INVESTIGATION OF ABUNDANT TREATED SEA SAND WITH DIFFERENT PERCENTAGES IN CONCRETE BRICK RATIO OF 1:3

MOHD SYAHMI HAFIZ BIN YASIN

A final Year Project Report submitted in partial fulfillment of the requirement for the award of the degree of Bachelor of Civil Engineering

Faculty of Civil and Environmental Engineering
University Malaysia Pahang

DECEMBER 2010

ABSTRACT

The Concrete bricks are usually used extensively in the construction industry as a wall panel, part of the construction of drains and so on. Usually, concrete bricks are using cement and normal sand such as Ordinary Portland Cement and river sand. In addition, the concrete brick also must have its own mix ratio for enabling the content to be a piece of brick. Usually, the use of river sand in our country is very widespread in the construction industry. Therefore, an alternative to use of river sand can be replaced with other materials to protect the environment of the river as well as prevent erosion and flooding. By using the abundant sea sand is one of the alternatives in the investigation of this concrete brick. River sand will be replaced with abundant sea sand in accordance with a specified percentage. The percentage of the abundant sea sand to replace with the river sand is 5%, 10%, 15% and 20%. In addition, a size of concrete brick was determined in this study, the size using is 225mm x 115mm x 75mm. The quantities of concrete bricks was made was 100 pieces and it will be tested in destruction test. The concrete bricks are placed in a water tank for the curing for 7 days and 28 days. Concrete brick was then tested with water absorption tests and compression strength test. These tests were conducted to ensure the quality of material, to reduce the cost and the important thing is to reduce the parties involved from having the problem at the next stages. This investigation shows that by using the abundant treated sea sand as replacing material with sand/cement ratio 1:3 is suitable and also can be used in construction industries.

ABSTRAK

Batu bata konkrit biasanya digunakan secara meluasnya dalam industri pembinaan seperti membuat dnding panel, bahagian di dalam pembinaan longkang dan sebagainya. Biasanya bata konkrit ini menggunakan campuran simen dan pasir biasa seperti Ordinary Portland Cement dan pasir sungai. Selain itu, bata konkrit juga mesti mempunyai nisbah campuran yang tersendiri bagi bagi membolehkan kandungan tersebut menjadi satu kepingan bata. Kebiasaanya, penggunaan pasir sungai di negara kita sangat meluas dalam industry pembinaan. Oleh sebab itu, satu alternatif bagi penggunaan pasir sungai dapat digantikan dengan bahan yang lain menjaga persekitaran dan keadaan sungai seperti mengelakkan hakisan dan juga banjir. Pengunaan lebihan pasir pantai adalah salah satu alternatif dalam penyelidikan bata konkrit ini. Pasir sungai juga akan digantikan dengan lebihan pasir pantai dengan mengikut peratusan yang ditetapkan. Peratusan bagi lebihan pasir pantai tersebut bagi menggantikan pasir sungai ialah 5%, 10%, 15% dan 20%. Selain itu juga, satu saiz telah ditetapkan dalam penyelidikan ini iaitu dengan menggunakan 225mm x 115mm x 75mm. Kuantiti bata konkrit ini adalah 100 biji bata konkrit dan akan menjalani ujian pemusnahan. Bata konkrit tersebut diletakkan didalam tangki air bagi proses rendaman selama 7 hari dan 28 hari. Bata konkrit kemudiannya diuji dengan ujian resapan air dan juga ujian mampatan. Ujian-ujian ini dilakukan adalah untuk memastikan bahan itu berkualiti, untuk mengurangkan kos dan yang penting ialah mengurangkan pihak-pihak yang terlibat dari menghadapi masalah yang akan timbul. Penyelidikan ini menunjukan penggunaan lebihan pasir pantai sebagai bahan gantian dengan nisbah 1:3 adalah sesuai dan boleh digunapakai dalam industri pembinaan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASTM	-	American Standard of Testing and Materials
BS	-	British Standard
NBRO	-	National Building Research Organization
OPC	-	Ordinary Portland Cement
SRPC	-	Sulphate Resisting Portland Cement
ACI	-	American Concrete Institute
MS	-	Malaysia Standard
W/C	-	Water Cement Ratio
MPa	-	Mega Pascal
Psi	-	Pound per Square Inch
N/mm^2	-	Newton per Millimeter square

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.0 Background of Study

Malaysia is a country has 4800 kilometers of coast, including islands such as Tioman Island, Langkawi Island, Pangkor Island, Burung Island and the Labuan Island. Beach of the Peninsular Malaysia has more than half of the coastline that is composed of muddy coastal areas and more of coastline is sand. In the East Sea coast of Peninsular Malaysia, 90% are sandy beaches and muddy areas that still remaining. Mustafa (2007) also stated that Sarawak that has sandy and muddy coast and also the coast of Sabah is mainly composed of having muddy areas.

Meanwhile, the East Sea coast of Peninsular Malaysia have a high percentage of sea sand and it can produce a problem of the overflow of sea sand at beach and known as a waste material. The waste material is a mixture of sea sand contain of clay and sand which gathered from under the sea bed. The emerging of the waste material will be occur mostly when the occurrence of monsoon season and tides.

Therefore, waste material which is sea sand can be used as one of innovation in the construction industry. It is the manufacturing of bricks with sea sand use as a replacing material processing which it is often use river sand as the brick-made material. In addition, the use of sea sand in the brick manufacturing might effect to the strength of the normal brick. However, sea sand is a fine material that suitable for producing of brick but the presence of chloride content in the sand could be contributed to the brittleness to the brick. The study about the sea sand in brick manufacture is important to exploit its benefit.

1.1 Problem Statement

The whole demand of sand was depending on river sand extracted for construction such as manufacture of brick (Shantha, 2006). The uncontrolled extraction of sand, river beds become lower than the mean sea level for miles and make river banks become unstable.

In addition, from the abundant of sea sand, it can make the aesthetic values for environmental view. Therefore, the abundant sea sand can be utilized in construction such as brick's producing. The use of sea sand as an abundant material by replacing to the brick might occur some changes in physical properties and also particularly in the mechanical properties of the brick.

The problem might occur to the brick when use sea sand as a replacing material such as improper quality of materials, incorrect specifications, faulty design, errors in construction process, and exposure of structures to the extreme environmental conditions.

1.2 Objectives

The objectives of this study are:

1. To investigate the compressive strength of brick ratio 1:3 by replacing the river sand with sea sand percentage of 0%, 5%, 10%, 15%, and 20%.
2. To determine the water absorption of bricks with the percentages of sea sand replacement.

1.3 Scope of Study

The sea sand samples will be taken from the Dungun, Beach at Terengganu. This is because, at Dungun Beach have much occur the overflow of sea sand and cause the abundant material at the beach. The replacing normal sand to sea sand will be experimented as composite in making concrete brick sample with the ratio of cement water and sand is 1: 3.

The experiment result will be used to ensure the effectiveness this ratio of sea sand in concrete batching to determine the compressive strength and also the absorption of the concrete brick. The percentages use in sea sand replacement in bricks is starting from 0% with the increment of 5% up to 20%. The sample must be completed about 100 samples of cement brick.

Table 1.1 Samples of Cement for Compressive Test

Percentage ratio	Days	
	7	28
0%	10	10
5%	10	10
10%	10	10
15%	10	10
20%	10	10
Total	50	50

The testing of this study is based on the source of material added and proportion of the material according to British Standard 3921 1985 (BS3921 1985). Below are the scopes of work for this study:

1. Test method for compressive strength of brick is based on BS3921 1985.
2. The abundant sea sand will be sieved by Sieve Analysis of Fine and Coarse Aggregate is based on ASTM C 136 – 05.
3. Test method for water absorption of brick is based on BS3921 1985.
4. Chloride content in Sea Sand must be treated by using Mercuric Thiocyanate Method.
5. The experiment use common brick size (BS3921 1985) is 225mm x 112mm x 75mm.

1.4 Significant of Study

The importance of this study is the replacing abundant sea sand in brick as the sea sand is a new material that might be effected to the cement and brick material for long life structure.

In addition, study of bricks contains sea sand in terms of physical properties such as shapes, size, and color and also chemical composition which is chloride content would be done. Besides that, by producing material containing this impurities might affects durability and shrinkage of cement brick.

Therefore, this study signifies to propose an alternative way in replacing river as fine aggregate of cement brick. Furthermore, it could be more realistic and flexible the developing construction industries if exposure usage of sea sand can be utilize.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The word of sand can be described as solid particles of a certain size, between 0.0625mm and 2mm diameter. In other words, sand can be described in terms of grain size, color, composition, morphology (angularity and shape) and surface texture. Grain size is a result of several factors, including composition, durability, severity of weathering condition and others. Sand is made of minerals and tiny pieces of rock that have come from the erosion and weathering of rocks (Anonymous 2010a).

The composition of sand varies from place to place depends on the sources and conditions of the local rocks. Sand is a unique raw material for the construction industry because allocations for obtaining bulk loads of sand for the construction work. According to C.Perera (2005), the global construction trade that sea sand is being used in the construction industry in the Asian region. Then, at the Civil Engineering Department of University of Moratuwa and the National Building Research Organization (NBRO) has confirmed that the sea sand pumped from a distance about ten kilometers is very suitable for the building construction industry because it has less chloride comparing with sea sand in beaches (Anonymous 2010b).

2.2 Sea Sand

Sea sand has become a potential resource capable to supplying fine aggregate material for domestic civil engineering and construction usage. In addition, by using the sea sand is economic then by using the river sand because the river sand is more expensive than the use of this inappropriate sea sand (Ismail, 2004).

Sea sand mainly contains much salinity as sodium chloride. If the salt is not treated and sea sand is directly utilized for civil engineering and construction concrete project, the durability of the structural may be affected and as the result the concrete might be swelling, precipitating, sulfating and other adverse consequences. Therefore, the salt content of the sea sand must be eliminated before it is utilized to avoid the potential hazards (Lee, 2002). The sand dunes are formed by sand particles blown by wind from sea shore. The top most layers of sand dunes contain higher chloride content due to continuous exposure to sea breeze (Shantha, 2006). However, when sea sand is actually utilized, the first problem encountered is the salt contained in the sea sand.

A distinction must also be made between sea sand and sand deposits in dry coastal areas. The latter would tend to have very high chloride contents resulting from salt spray and evaporation over long periods of time. Research carried out by Chapman and Roeder at 1987 has established that hollow shells in sea sand get filled with cement paste or mortar, and that their hollowness does not impair either concrete strength or impermeability. In addition, their flakiness, which may reduce workability, has also been found to be offset by their smoothness, and also the greater roundedness of the sea sand itself (Dias *et al*, 2007).

2.2.1 Sieve Analysis Sea Sand

The sieve analysis of sea sand is to determine the gradation of sea sand such as the distribution of aggregate particles, by size and within a given sample. The Figure 2.1 shown below is the sieve analysis of sea sand that use as concrete aggregate.

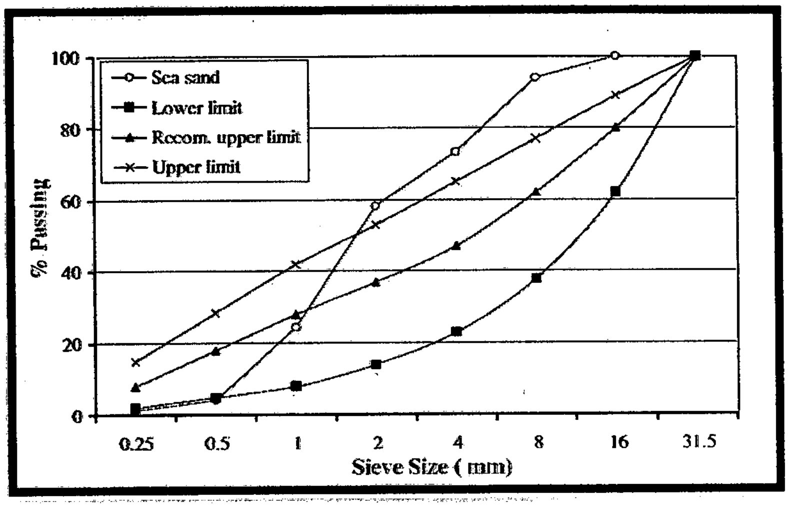

Figure 2.1: Average Granulometric Curve of Typical Sea Sand Used As Concrete Aggregate

Source: Ismail, 2004

The Figure 2.1 show that, the percentage of passing sea sand to get 100% on sieve analysis and sieve size is quickly than other material. This occurs since the sea sand is a fine aggregate that less retains in sieve size. Mechanical sieve shaker, if used, must provide a vertical or lateral and vertical motion to the sieve, causing the particles thereon to bounce and turn so as to present different orientations to the sieving surface. Sieve shakers must provide sieving thoroughness within a reasonable time.

Table 2.1 shows the key characteristics of the grading curves for various offshore sand samples. This shows that differences between the typical, medium and coarse offshore sand samples are small, with a D50 value around 0.6 mm, while the fine sample is considerably different. A D50 value of around 0.6 mm is very good for concrete production. Such values tend to be much lower in the European offshore sand deposits, say between 0.2 and 0.4 mm (Dias *et al*, 2006).

Table 2.1 Grading Characteristics of Fine Aggregate

Characteristic	Sea sand types			
	Typical	Coarse	Medium	Fine
<0.60 mm (%)	44	42	49	85
<0.15 mm (%)	2.6	2.5	2.7	12
D50 (mm)	0.63	0.66	0.60	0.21

Source: Dias *et al*, 2006

As can be seen in the objective of sieve analysis, this research investigated the grade of a sample of fine aggregate. As a basic material in brick mix, a classification of aggregate is very important. It should have been considered because it will effect to the strength of brick. According to that, the analysis for fine aggregate is needed. The advantages of sieve series of this nature are that the size of apertures decreases in logarithmic fashion, thereby facilitating the recording of the results and at the time giving the correct relative order of importance to fine particles. A maximum chloride content of 0.075% by weight of sand could therefore be deemed acceptable for all reinforced concrete work using a 20 mm maximum of aggregate size and Portland cements (Dias *et al*, 2007).

2.3 Chloride

Chloride content might be present in the concrete when it was exposed to the environment. In addition, Chloride may be added to the concrete as impurities of the constituent material or added to the concrete by mean of mixtures. Furthermore, the Ordinary Portland Cement has 0.01% until 0.05% of chloride content and it can measure the total chloride in the concrete mix (Dias *et al*, 2007). Thus, left as predominant chloride sources are seawater, de-icing salt and industrial process. For this research, the seawater will be taking as chloride source in concrete (Ervin *et al*, 2006).

Seawater and brackish water contain substances which are aggressive against concrete and especially to steel reinforcement concrete. Magnesium sulphate might present in the seawater and cause the diffusibility of the concrete by forming a coating of brucite, $Mg(OH)_2$. Other reactions may take place in forming aragonite, $CaCo_3$. Diffusibility of concrete that can expose to seawater and in the laboratory to water containing chloride may differ and also when all other parameter is equal (Ervin *et al*, 2006).

2.3.1 Chloride Content in Sea Sand

The chloride content in sea sand depends on the chloride content in sea water. The sea water contains relatively constant chloride content but more moisture content in sand retains more chloride around particles. In hot climates, though the moisture content is less, due to evaporation of moisture chloride coating will be formed around particles. BS 5328 Part 1: 1991 specifies total chloride limit to 0.4% by weight specifies. However, this guide line is not suitable due to difference in climatic condition (Shantha, 2006).

Sea water has an ion chloride (Cl^-) content of 1.98%, although there would be local fluctuations. The moisture content of the sand after drainage would depend on the grading of the sand, which can be characterized by its D50 value for the example the theoretical sieve size below which 50% of the sand mass would pass in a sieving test. Sands with low D50 values and high ultrafine contents would have greater capillary action and retain more moisture (Dias, 2007).

According to Shantha (2006), and by referring to BS 812-117:1988 the results of sea sand was as shown in Table 2.2 with used of Silver Nitrate Solution

Table 2.2 Chloride Content with used of Silver Nitrate Solution

Sample	Ion chloride (Cl-) content (%)
Sample from sea shore	0.16
Sample from stock pile (Off shore)	0.03

Chang (2008) studied that, the determination of the salt content of seawater is an important area of research since ocean currents and global climate are affected by salt content. The primary ionic components of seawater are shown in the Table 2.3. These include large amounts of chloride (Cl^-) and sodium (Na^+) ions.

Table 2.3 Ionic Components of Seawater

Ion	**Grams per 1000g seawater**	**Mass %**
Cl^-	19	1.9
Na^+	10.7	1.07
SO_4^{2-}	2.7	0.27
Mg^{+2}	1.3	0.13
Ca^{+2}	0.4	0.04
K^+	0.4	0.04

Source: Chang (2008)

2.3.2 Chlorides in Sands

From the BS5628 – 2-100, the chloride ion content by mass of dry building sand should not exceed 0.15 % (*m*/*m*) of the cement. The total chloride content of concrete and mortar mixes arising from aggregates and any other sources should not exceed the limits given in Table 2.4.

Table 2.4 Chloride Content of Mixes

Type or use of concrete or mortar Maximum total chloride	Maximum total chloride content by mass of cement % (*m*/*m*)
Pre-stressed concrete; heat-cured concrete containing embedded metal	0.1
Concrete or mortar made with cement conforming to BS 4027	0.2
Concrete or mortar containing embedded metal and made with cement conforming to BS 12 or BS 146	0.4

Source: BS5628 – 2-100

The table shows that the maximum total chloride content by mass of cement in percentage for the unit m/m will be increased according the type of material which used in making the concrete works. For the pre-stressed concrete which containing embedded metal must be low of the total chloride content. For the concrete or mortar containing embedded metal and made with cement conforming to BS 12 or BS 146, the maximum of total chloride content is high than the concrete or mortar made with cement conforming to BS 4027.